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DECLARATION

I, **Mr MECIL, of A.R.T International BP 114 95170 DEUIL-LA BARRE France**

Do hereby declare that I am conversant with the English and French languages and am a competent translator thereof.

I declare further that the following is a true and accurate translation into English of the

French Patent Application N° 98 00100 filed on 05 January 1998.

Signed in DEUIL-LA-BARRE

This 26th day of September 2001

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PATENT

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PATENT, CERTIFICATE OF USE
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APPLICATION FOR ISSUE OF CERTIFICATE
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DATE DOCUMENTS SUBMITTED: 5 JANUARY 1998 **NATIONAL REGISTRATION NUMBER:** 98 00100 **DEPARTMENTAL REGION OF FILING:** **DATE OF FILING:** 5 JANUARY 1998	**1 NAME AND ADDRESS OF APPLICANT OR AGENT TO WHOM CORRESPONDENCE IS TO BE SENT** PECHINEY Mr. Daniel Maurice 28, Rue de Bonnel Lyon CEDEX 03 Permanent proxy No.LC004A References of correspondent: BR 3262 - DM/NP Telephone: 04 78 6291 53
2. APPLICATION (Type of patent rights) ☐ patent ☐ divisional application ☐ certificate of use ☐ conversion of application for European patent	12.06.98 FD 295
Search report ☐ **deferred** ☐ **immediate** The applicant, a natural person, requests payment of fees in instalments ☐ **yes** ☐ **no**	
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3. APPLICANT SIREN NO. Name and forenames (underline family name) or company name 1. SOCIETE POUR LES TRANSPORTS, DE L'INDUSTRIE NUCLEAIRE - TRANSNUCLEAIRE 2. COGEMA - COMPAGNIE GENERALE DES MATIERES NUCLEAIRES **Nationality: FRENCH**	**Legal form** Limited Liability Company
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8. Signature of applicant or agent (name and capacity of signatory - Reg. No.)	Signature of officer on receipt	Signature after INPI registration
Daniel Maurice 422-5/PP.361	D. Giraud	" Signature "

PATENT OF INVENTION, CERTIFICATE OF USE

BR 3262 DM/NP DESIGNATION OF THE INVENTOR

(if the applicant is not the inventor or the only inventor)

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TITLE OF THE INVENTION

DEVICE FOR TRANSVERSE IMMOBILIZATION OF NUCLEAR FUEL INSIDE TRANSPORT CONTAINERS.

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Date and signature of the applicant or his/her representative
5 January 1998

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DEVICE FOR TRANSVERSE IMMOBILIZATION OF NUCLEAR FUEL ASSEMBLIES INSIDE TRANSPORT CONTAINERS

Technical field

The invention relates to a device for transversely immobilizing nuclear fuel assemblies in their transport container.

State of prior art and problem caused

New, long uranium oxide based fuel assemblies with a prismatic shape intended for use in nuclear power stations, for example of the PWR or BRW type, are normally transported in relatively light containers or canisters (total laden weight not exceeding 5 t).

The container usually contains two to four assemblies placed in housings or cradles so that the said assemblies can be accessed directly over their entire length.

Due to this direct access, the assemblies can be immobilized transversely in their cradle, usually located at spacing grids. In particular, this immobilization guarantees the integrity of the assemblies that must not be subjected to forces exceeding the allowable limits imposed by the designer of the assembly model, during transport or handling. Furthermore due to this direct access, the various technical problems caused by safety in these transport systems (criticality, shielding, temperature, mechanical) are solved simply.

However, the recent use of mixed fuels, in other words containing a mixture of uranium and plutonium oxide, which is to become generalized, requires enhanced safety measures during transport, particularly for sea transport to other countries.

Thus, this transport must now be done in heavy containers with thick walls of the 100 t class, of the type used for the transport of irradiated assemblies.

These heavy containers comprise a long, thick cylindrical wall (usually about 20 to 40 cm thick) made of steel or cast iron, with a thick permanently fixed bottom at one of its ends, and closable at the other end by one or several thick removable covers. They are loaded through the end that can be closed.

The container cavity usually comprises a storage compartment comprising long compartments parallel to the center line of the container, the shape of each compartment being designed to match the type of fuel assembly to be housed in it.

Due to the fact that loading takes place through one end of the container, it is impossible to have direct access to the entire length of the assembly and to immobilize fuel assemblies in their compartments transversely in the same way as was done before.

Thus the applicant searched for a device that could immobilize the fuel assemblies transversely working from the open end of the container, after the assemblies had been put into their compartments.

Description of the invention

The invention is a device for transverse immobilization of long nuclear fuel assemblies housed in compartments of the same length, delimited by walls, characterized in that it comprises:

- a fixed structure rigidly attached to the compartment, located on one of its surfaces and comprising at least one guide element transverse to the length of the assembly,
- a structure that can be moved in the transverse direction, capable of applying pressure on the fuel assembly and comprising at least one transverse guide element working in cooperation with that of the fixed structure element,
- an adjustable clamping means comprising at least one adjustable clamping element capable of clamping or unclamping the mobile structure on the fuel assembly using an adjustment device, and a control device that can be manipulated from the accessible end of the fuel assembly, the said control device acting on the clamping element or its adjustment device to clamp the assembly in position by reaction on the fixed structure, or to release it.

The fixed structure may be a section or segments of rigidly fixed sections along the length of the compartment. It may also form an integral part of the compartment.

The mobile structure usually includes a plane plate parallel to a surface of the compartment; it is

usually a portion cut out of the compartment wall. In order to immobilize the fuel element, it usually bears on the fixed structure and applies pressure on the spacing grids of the said fuel assemblies, so that the clamping force can be distributed over the entire length of the said assembly.

Clamping elements may be rigid, or preferably elastic (spring leaf). They may be fixed to the fixed or mobile structure or the control device. The same is true for the adjustment devices with which they work in cooperation. The clamping force can be adjusted or released, depending on the relative position of the clamping elements and their adjustment devices.

Fixed and mobile structures may advantageously be connected to each other by return springs that facilitate the clamp release operation necessary to extract the assembly from its compartment.

In general, fixed and mobile structures are located on the same compartment wall.

Transverse guide elements are usually cylindrical and slide into each other; they comprise a male part and a female part, one being on the fixed structure and the other on the mobile structure; they may also be slides or slide elements distributed along the fixed and mobile structures, or any other equivalent system.

A compartment may comprise one or several immobilization devices located on one or several of its surfaces, in order to provide transverse immobilization of the assembly in all directions. Thus, when the cross section of the compartment is square, it is

useful to place an immobilization device on two adjacent surfaces.

In a heavy container of the type described above, there are usually a plurality of compartments with their immobilization devices that can be manipulated and adjusted from the open end of the said container. The compartments may be made fixed to each other to form a long compartment with a compartmentalized structure, each compartment comprising at least one immobilization device. Compartments have a prismatic cross-section corresponding to the cross-section of the assembly that will fit into them.

Figures 1 to 4 illustrate the invention and provide a better understanding of it.

- Figures 1a and 1b show a cross-section and longitudinal section respectively through a compartment in which a single assembly of guide elements and clamping means according to the invention have been shown, although usually several of these devices are installed along the compartment.

- Figures 2, 3 and 4 represent three practical alternative embodiments of clamping means that are remotely controlled from the end of the assembly, according to the invention.

Figure 1 shows a compartment 1 and a housing 2 in which a fuel assembly (not shown) with a square cross-section will be positioned.

The fixed structure 3 is rigidly fixed to a wall 4 of the compartment. A female transverse guide element 5 is attached to it.

The structure 6 free to move transversely is a plane plate parallel to the assembly, and preferably partly or sometimes completely replaces the wall of the compartment. A male transverse guide element 7 is fixed to it and works in cooperation with the female guide element 5 on the fixed structure 3. Usually, this mobile structure immobilizes the fuel assembly by applying pressure to its spacing grids.

The adjustable clamping means with its remote control device is shown diagrammatically as 8, and is located between the fixed and mobile structures.

Figure 2a (longitudinal section) and figure 2b (cross-section) show a first alternative embodiment of the adjustable clamping means with its remote control device.

A clamping element can be seen in the form of one or several spring leaves 10 separated from each other, in which one free end bears on a plate 11 rigidly fixed to the structure which is free to move in the transverse direction 6, and the other end is fixed to the fixed structure 3 through a hinge 12 and its support 13. The adjustable clamping force is applied by pressing on each of the spring leaves 10 using an adjustment device comprising the same number of bars 14 fixed rigidly at one or both ends to an upright 15 parallel to the major axis of the assemblies, moveable in this "longitudinal" direction used as a control device. The end of the upright 15 is located at the free end of the compartment located on the opening end of the container.

Thus, it can be seen that by manipulating the rigid control device 14, 15 longitudinally, the clamping of the fuel assembly can be adjusted starting from the open end of the container, by pressing more or less on the leaves 10.

The upright 15 can be moved longitudinally by sliding it in a section 16 with an appropriate shape, rigidly attached to the fixed structure 3.

Several clamping assemblies comprising leaves 10, their hinged attachment 12, 13 and the thrust plate 11 are usually set out along the compartment, the control device then comprising the same number of sets of bars 14. Similarly, it is sometimes, and in general, advantageous to place two control devices with their elements and the associated clamping devices, parallel to each other on the same side of the compartment.

Figure 2a also shows a transverse guide device comprising a male guide element 7 fixed on the mobile structure 6. The corresponding female guide element 5 is attached to the fixed structure 3; a return spring device is shown in 17.

Figures 3a (longitudinal section) and 3b (cross-section) show a second alternative embodiment of the adjustable clamping means with its remote control device.

The clamping means comprises at least one clamping element comprising an elongated curved spring leaf 20, placed longitudinally; its convex surface is located facing the structure 6 free to move transversely (usually composed of the wall, or parts of the wall, of

the compartment, as already mentioned); it is fixed on a support 21 at one of its ends, the support sliding longitudinally, projecting from the accessible end of the compartment containing the fuel assembly and which can be manipulated from the open end of the container. This support 21 bears on the fixed structure 3 attached to the compartment 4. The other end of the leaf spring 20 remains free, and is supported on the said fixed structure preferably through the support 21.

The adjustment device contributing to immobilizing the assembly in the compartment comprises essentially a roll 22 and its support 23 rigidly fixed to the mobile structure 6 the roll being laid out such that it is supported on, and cooperates with, the convex surface of the leaf spring 20 to control the transverse displacement of the mobile structure 6 and the adjustable clamping of the fuel assembly.

This illustrates how the clamping can be adjusted from the outside of the container by more or less sliding the support 21 to provide a variable pressure on the roll 22 and therefore on the mobile structure 6.

As above, several clamping assemblies of this type may be distributed along the compartment. The transverse guide means that may be similar to those in figure 2a, are not shown.

Figure 4 (longitudinal section) represents a third alternative embodiment of the adjustable clamping means with its remote control device.

This clamping means comprises essentially at least one pair of connecting rods 31, 32 (in this case two

pairs are shown), one of the ends of which is fixed using a hinge to a sleeve 33 free to move longitudinally and acting as the adjustment device. The other end of the "fixed" connecting rod 31 is rigidly attached to the fixed structure 3 through another hinge, whereas the other end of the "mobile" connecting rod 32 is rigidly attached to the mobile structure 6 once again through a hinge. Connecting rods 31, 32 are positioned so that they form a V and may advantageously be spring leaves.

Sleeve 33 is moved longitudinally by any means projecting from the accessible end of the compartment, advantageously using a worm screw 34 that does not move longitudinally, for example rigidly attached to the fixed structure 3; the said worm screw 34 then cooperates with a screw thread formed in the sleeve 33. The worm screw 34 may be fixed longitudinally by means of at least one support arm 35 fitted with an oblong bore enabling the worm screw 34 passing through it to move transversely in a direction perpendicular to the fixed structure 3 and the mobile structure 6. The support arm 35 with its oblong bore cooperates with a bearing located on the said screw 34 between two stops preventing it from moving in the longitudinal direction.

It can be seen that rotation without longitudinal displacement of the screw 34 controlled from outside the container causes a variable opening in the V formed by the connecting rods 31, 32, such that the fuel assembly clamping force can be adjusted.

As above, several devices comprising sleeves 33 with their connecting rods 31, 32, may be placed along the length of the compartment and the transverse guide means, which may be similar to those in figure 2a, are not shown.

However, these guide means may advantageously be replaced by connecting rods 31, 32, usually at their hinged end on the sleeve 33, with a device working in cooperation with the worm screw 34 (for example a sector of toothed wheel) in order to impose a variable angle on the V formed by the connecting rods 31, 32, depending on the position of the sleeve 33 and in order to provide the transverse guide and clamping for the mobile structure 6.

Figure 5 (longitudinal section) represents a fourth alternative embodiment of the adjustable clamping means with its remote control device.

This means with pneumatic control comprises essentially a cylindrical jack body 41 with its axis in the transverse direction, rigidly attached to the fixed structure 3 and comprising a guide rod 42 along its axis, with an inlet duct 43 drilled along its axis to carry a compressed gas opening out at its end.

A fixed piston 44 is rigidly attached to the said end of the guide rod 42; it comprises seals 45 at its periphery.

The periphery of jack body 41 comprises a plurality of cylindrical chambers 46 with their axis parallel to the axis of the piston; there is a compression spring 47 in each of the chambers.

A mobile collar 48 inside the jack body 41 is adjusted to the shape of the said jack body; this collar is inserted between the fixed piston 44 and the jack body 41 and slides along the guide rod 42 by means of a corresponding bore formed in the said collar 48.

The collar 48 also comprises a plurality of housings 49 around its periphery that nest onto each of the chambers 46 in an adjustable manner.

The collar that is moved transversely to the longitudinal direction of the fuel assembly is rigidly attached to the mobile structure 6.

A compressed gas, typically air, may be added into the space located between the fixed piston 44 and the mobile collar 48 through duct 43.

The seal is formed by seals 45 located around the periphery of the fixed piston 44 and by a seal 49 located in the bore of the collar 48 and bearing on the guide rod 42.

It can be seen the mobile structure 6 is clamped onto the fuel assembly by the springs 47, and that the compressed gas is used to release and/or adjust the clamping force by counterbalancing the force applied by the springs 47. It can also be seen that the compressed gas may easily be supplied and adjusted starting from the open end of the container.

One particular advantage of this device is that it provides both transverse guide means for the mobile structure 6 and clamping means.

As above, several devices of this type are usually distributed along the compartment.

One alternative of this device consists of adapting it such that the compressed gas, for example added between the mobile collar and the jack body, controls clamping of the said mobile collar which is then modified such that the said space is gastight and the return springs release the clamping forces.

Other alternatives of the adjustable clamping means according to the invention could be made. For example, it would be possible to use a control device comprising a rod or a worm screw projecting from the free end of the compartment, as in the third alternative above, which controls the movements of clamping cams which bear on the mobile structure when the said rod or screw is manipulated.

CLAIMS

1. Device for transverse immobilization of long nuclear fuel assemblies housed in compartments of the same length with several walls, characterized in that it comprises:

- a fixed structure (3) rigidly attached to the compartment, located on one of its surfaces and comprising at least one guide element (5) transverse to the longitudinal direction of the assembly,

- a structure (6) that can be moved in the transverse direction, capable of applying pressure on the fuel assembly and comprising at least one transverse guide element (7) working in cooperation with the element (5) on the fixed structure (3),

- an adjustable clamping means (8) comprising at least one adjustable clamping element (10, 20, 31, 32, 47) capable of clamping or unclamping the mobile structure (6) on the fuel assembly using an adjustment device (14, 22, 33, 48), and a control device (15, 21, 34, 43) that can be manipulated from the accessible end of the fuel assembly, the said control device acting on the clamping element or its adjustment device to fix the assembly in position by reaction on the fixed structure (3), or to release it.

2. Device according to claim 1, characterized in that the mobile structure (6) comprises a plane plate parallel to the fuel assembly replacing at least part of the compartment wall.

3. Device according to any one of claims 1 or 2, characterized in that the clamping elements (10, 20, 31, 32, 47) are elastic.

4. Device according to any one of claims 1 to 3, characterized in that the guide elements (5, 7) fixed on the fixed structure (3) and the mobile structure (6) slide in each other.

5. Device according to any one of claims 1 to 4, characterized in that the fixed structure (3) and the mobile structure (6) are connected together by a return spring (17).

6. Device according to any one of claims 1 to 5, characterized in that the adjustable clamping means (8) comprises:

at least one clamping element comprising one or several spring leaves (10) separated from each other, of which a free end bears on a plate (11) rigidly attached to the structure (6) that moves in the transverse direction, and the other end is rigidly attached to the fixed structure (3) by means of a hinge pin (12) and its support (13),

an adjustment device comprising one bar (14) for each leaf (10), rigidly fixed at at least one of its ends to a control device comprising an upright (15) parallel to the major axis of the fuel assemblies, which can be moved along this direction and projecting

from the accessible end of the compartment, each of the said bars (14) being supported on a spring leaf (10).

7. Device according to claim 6, characterized in that the upright (15) slides inside a section (16) rigidly attached to the fixed structure (3).

8. Device according to any one of claims 1 to 5, characterized in that the adjustable clamping means (8) comprises:

at least one clamping element comprising a curved spring leaf (20) with an elongated shape, placed longitudinally with a convex surface facing the mobile structure (6) that is free to move in the transverse direction and supported on an adjustment device comprising a roll (22) fixed to the said mobile structure (6) through a support (23),

a control device comprising a support (21) free to slide longitudinally, projecting from the accessible end of the compartment and bearing on the fixed structure (3), the leaf spring (20) being fixed at one of its ends on the said support (21), the other end being free and bearing on the said support (21).

9. Device according to any one of claims 1 to 5, characterized in that the adjustable clamping means (8) comprises:

at least one clamping element comprising at least one pair of connecting rods, one being called the "fixed" rod (31) and the other the "mobile" rod (32),

one of their ends being fixed to a sleeve (33) moving in the longitudinal direction, using a hinge, the other end of the "fixed" rod (31) being rigidly attached to the fixed structure (3) by means of a hinge, the other end of the "mobile" rod (32) being rigidly attached to the mobile structure (6) by means of a hinge, the rods (31, 32) being positioned such that they form a V with a variable angle;

a control device (34) rigidly attached to the fixed structure (3) used to activate the sleeve (33) longitudinally starting from the accessible end of the compartment.

10. Device according to claim 9, characterized in that the control device comprises a worm screw (34) that does not move longitudinally and that cooperates with a screw thread formed in the sleeve (33).

11. Device according to any one of claims 1 to 5, characterized in that the transverse guide elements (5, 7) and the adjustable clamping means (8) are combined.

12. Device according to claims 9, 11, characterized in that the combined transverse guide and clamping means comprise a device fixed to the connecting rods (31, 32) that cooperates with the control device (34) to impose an angle on the V formed by the connecting rods (31, 32) that depends on the position of the sleeve (33).

13. Device according to claim 11, characterized in that the combined guide elements and the adjustable clamping means comprise:

a cylindrical jack body (41) with a transverse axis, rigidly attached to the fixed structure (3) comprising a guide rod (42) in which a compressed air inlet duct (43) has been formed along its axis projecting from its free end, a plurality of cylindrical chambers (46) at its periphery with an

axis parallel to the jack axis, each of the chambers (46) containing a compression spring (47),

a fixed piston (44) rigidly attached to the said free end of the guide rod (42) comprising a seal (45) at its periphery,

a mobile collar (48) rigidly attached to the mobile structure (6) located inside the jack body (41) and adjusted to the shape of the said jack body, this collar being inserted between the fixed piston (44) and the jack body (41) and sliding along the guide rod (42) along a corresponding bore formed in the said collar (48), the said collar also comprising at its periphery a plurality of housings (49) that nest in an adjusted manner into each of the chambers (46) by moving transversely to the longitudinal direction of the fuel assembly,

a compressed gas supply means opening at the accessible end of the compartment and carrying gas into the space located between the fixed piston (44) and the mobile collar (48) through the duct (43), the springs (47) clamping the mobile structure onto the fuel assembly.

14. Device according to any one of claims 1 to 5, characterized in that the adjustable clamping means (8) comprises a control device opening to the outside of the compartment which controls the cams which bear on the mobile structure (6).

Sheet before rectification

15. Compartment forming a housing for nuclear fuel assemblies characterized in that it is equipped with one or several immobilization devices according to claims 1 to 14.

16. Container for the transport of nuclear fuel assemblies, characterized in that it comprises a plurality of compartments according to claim 15.

axis parallel to the jack axis, each of the chambers (46) containing a compression spring (47),

a fixed piston (44) rigidly attached to the said free end of the guide rod (42) comprising a seal (45) at its periphery,

a mobile collar (48) rigidly attached to the mobile structure (6) located inside the jack body (41) and adjusted to the shape of the said jack body, this collar being inserted between the fixed piston (44) and the jack body (41) and sliding along the guide rod (42) along a corresponding bore formed in the said collar (48), the said collar also comprising at its periphery a plurality of housings (49) that nest in an adjusted manner into each of the chambers (46) by moving transversely to the longitudinal direction of the fuel assembly,

a compressed gas supply means opening at the accessible end of the compartment and carrying gas into the space located between the fixed piston (44) and the mobile collar (48) through the duct (43), the springs (47) clamping the mobile structure onto the fuel assembly.

14. Device according to any one of claims 1 to 5, characterized in that the adjustable clamping means (8) comprises a control device opening to the outside of the compartment which controls the cams which bear on the mobile structure (6).

Sheet after rectification

15. Compartment forming a housing for nuclear fuel assemblies characterized in that it is equipped with one or several immobilization devices according to any of claims 1 to 14.

16. Container for the transport of nuclear fuel assemblies, characterized in that it comprises a plurality of compartments according to claim 15.